

gan to fall over the Florida Peninsula and the eastern Gulf. Over the western Gulf the pressure continued to rise. *The recurve of these cyclones was apparently due to the obstruction offered to a westward course by anticyclonic areas which had advanced or had been drawn from the continent over the west Gulf and the Southwestern States.*

Thirty-two per cent of the cyclones traced did not recurve to the northward, and had no easterly movement. A large proportion of the cyclones of this class advanced from the eastern West Indies. Upon their arrival in about longitude W. 80°, the average longitude in which September cyclones recurve, the pressure over the west Gulf began to decrease, and rain set in, and the interior-eastern districts of the United States were occupied by an extensive anticyclonic area. As storms prefer to follow the path of least resistance, the centers moved toward the region of decreasing pressure and avoided the high and increasing pressure to the northward. When the pressure continued high over the eastern districts of the United States the storms were unable to recurve and were penned in over Mexico or the Southwestern States. In such cases the cyclones usually developed great violence before dissipating. Similarly cyclones of this class that advanced northwestward toward the middle or south Atlantic coasts of the United States were apparently prevented from recurring by high pressure over the ocean to northward and northeastward. Description of storms of this class will be

found in the MONTHLY WEATHER REVIEW for September, 1888, and September, 1889. The storm of September, 1888, raged with fearful violence over Cuba and passed thence to southern Mexico. The storm of September, 1889, was exceptionally severe, and dissipated off the middle Atlantic coast.

*It may be assumed that with a nearly normal distribution and movement of atmospheric pressure September cyclones will recurve near longitude W. 80° and between latitudes N. 25° and 28°. When a cyclone is central east of Cuba and an area of high pressure is advancing eastward over the Gulf and south Atlantic States, the cyclone will probably recurve east of the Bahamas. When the cyclone reaches central Cuba or longitude W. 80°, and an area of high pressure is advancing over the west Gulf and Southwestern States, the cyclone will probably recurve over Florida or the east Gulf. When the cyclone reaches the seventy-fifth meridian and an area of high pressure is overspreading the interior and eastern districts of the United States, with stationary or falling barometer over the west Gulf and the Southwestern States, the cyclone will probably advance westward over the Gulf of Mexico. When cyclones are moving northwestward toward the south or middle Atlantic coasts of the United States, and the pressure is abnormally high over the Northeastern States and the Canadian Maritime Provinces, the chances are that the storm will not recurve but will be crowded in upon the coast and develop destructive energy.*

## SPECIAL CONTRIBUTIONS.

### CLOUD PHOTOGRAPHY.

By ALFRED J. HENRY, U. S. Weather Bureau. Written August, 1895.

A considerable mass of information concerning the condition of the air at the surface of the earth has been accumulated, but we know very little of what is going on at some distance above us. The regions of the higher atmosphere have been studied to some little extent through the scant data afforded by balloon ascensions, mountain meteorological observatories, and the movements of upper clouds. While the latter method is not so promising in direct results as others that might be mentioned, its simplicity and adaptability commend it to all lovers of science.

The question of cloud photography is of especial interest at the present time in view of the following resolutions passed by the International Meteorological Committee at its meeting in Upsala, August 20-24, 1894:

Since experience shows that the altitude of clouds can be easily determined with sufficient accuracy, the introduction of these investigations into all countries is recommended, preferably by the use of the photographic process. Observations of direction and relative velocity should be made at as many stations as possible, and measures of height at a limited number of suitably distributed stations.

The value of these investigations would be greatly increased if made at the same epoch; therefore, it is proposed that they be commenced May 1, 1896, and continue for one year.

Cloud photography has received more attention during the last ten years than at any time since the introduction of dry plates, and it is now possible, as a result of the combined efforts of amateur photographers and meteorologists to obtain fairly good negatives with comparatively little difficulty. The employment of the camera to permanently fix the appearance of the sky and the changes in form of clouds can not be too strongly recommended. One of the most practical results likely to flow from a close watch of the sky is the ability to associate various cloud forms with coming weather changes. After an experience of four years in this regard I am confirmed in the belief that for the purpose of forecasting the weather from the standpoint of the solitary observer the clouds afford the most valuable data at his command.

With a view of increasing activity in cloud work during the coming year of special observation and to encourage all who may be inclined to take an active interest in cloud photography, the following suggestions are offered:

*Apparatus.*—No particular form of camera is required. Hand cameras have the advantage of being ready for use at a moment's notice, and when a cloud mass is changing rapidly it is possible to make a series of exposures at a very few seconds' interval. For the best results, however, a tripod camera should be used (unless one adopts the expensive photogrammetric apparatus). A lens of the rectilinear type, having a focal length equal to the diagonal of the plate used, is best suited for cloud work, and one should always be careful to adjust the camera so that the sensitive plate shall be exactly perpendicular to the optical axis of the lens.

*Plates.*—It is perhaps unnecessary to state that when any color is looked at with the naked eye the sensation experienced is the joint effect of the various elementary colors of which it is composed. When we examine the colors of the spectrum as regards their action on the ordinary photographic plate, we find that those of the greatest visual intensity—yellow and orange—have the least actinic effect, while the blue and violet rays are especially active. When we attempt to photograph the spectrum with the ordinary commercial dry plate, we find that the blue and violet rays are rendered almost white and the remainder of the colors of a uniform blackness.

To reproduce these colors in their correct chromatic value we must use plates that are specially sensitive to the most luminous rays and restrain those rays that are most active, and this is what dry-plate makers aim to accomplish with the so-called isochromatic or orthochromatic plate.

There are various brands of orthochromatic plates on the market, such as Cramer's, Carbutt's, Wuestner's, and others, and, since they tend to maintain the natural relations of light and shade, they are to be recommended for cloud work, although there are conditions when an ordinary slow plate may be used to good advantage. Before determining upon the special plate to use, it is advisable to make a comparative

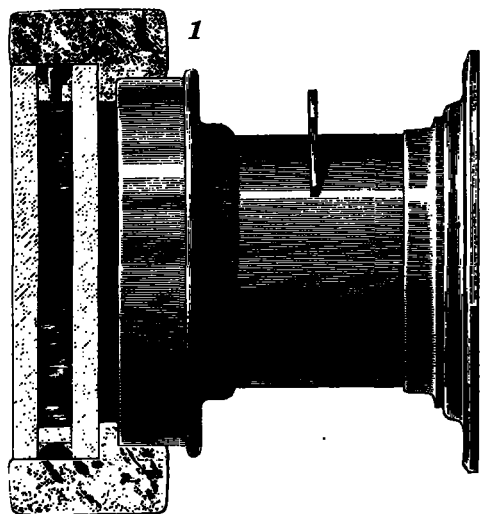
test of those above named, at least. The experience thus gained will be quite valuable and will amply repay one for the expense of the plates.

Orthochromatic plates necessarily require a little more care in their treatment than ordinary plates, since they are especially sensitive to yellow light of any kind. A dark-room light that is safe for a quick plate of the ordinary kind may fog an orthochromatic plate.

*Screens.*—It is found that the interposition of a suitable color screen between the clouds and the sensitive plate, in order to restrain or subdue the blue and violet rays, adds greatly to the resulting photograph. Various screens have been devised and used with greater or less success. Dr. Riggenbach, of Basle, as early as 1888, described a method that gives very good results. He places a black mirror in front of the lens, so that the plane of the mirror makes an angle of about  $33^\circ$  with the axis of the lens, and thus takes advantage of the fact that some of the blue light of the sky is polarized in a certain plane and is lost by reflexion, while that from a cloud is not. A Nicol prism, or other polarizing apparatus, also gives good results.

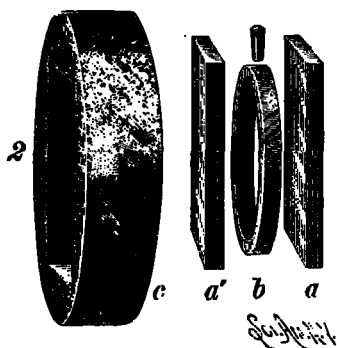
In my work, however, only glass and liquid screens have been used. The screen first devised was described and figured in the *Scientific American* of March 2, 1895.

Through the courtesy of Messrs. Munn & Co., editors and proprietors of that journal, we are able to reproduce the illustrations given herewith. Fig. 1 shows the manner of attach-



ing the screen to the lens. There is no objection to placing the screen back of the lens in the dark chamber of the camera, but it is most convenient to attach it as shown in the drawing.

The second drawing shows the construction of the cell. *a a'* are squares of plate glass, and *b* is a ring cut from a glass tube and ground to render its edges parallel and smooth. The ring is cemented between the two glass plates with balsam of fir or other suitable cement. Two holes are cut in the ring for the introduction of the liquid, one at the top and another at the bottom. The second hole serves to empty the cell quickly; it is not shown in the drawing. A piece of cork, *c*, is used to attach the screen to the front of the lens. The thickness of the screen is shown in the drawing, the diameter will of course vary with the size and angle of the lens.



Theoretically the use of a liquid screen, such as described, should give a slightly distorted image at the edges of the plate, owing to the varying refractive powers of the different media through which the rays of light pass. In practice, however, the distortion, if any, is so slight as to be imperceptible to the naked eye.

The liquid used in the cell is a solution of bichromate of potash, as recommended by Mons. Angot of the French Meteorological Bureau. It is most convenient to make a 10 per cent solution and dilute it until the required density is reached. A 2 per cent solution is sufficiently dense to photograph cumuli and well-lighted clouds when the contrast between cloud and sky is well marked. For cirrus an 8 per cent solution may be used, but there is danger of blurring from prolonged exposure if the clouds are moving rapidly. For this reason a 5 per cent solution with a quick exposure is preferred. The glass color screen, made by Carbutt, is about equivalent to a 2 per cent bichromate solution.

In preparing the bichromate solution care should be taken to see that it is not dense enough to cut off all of the blue rays, the absence of blue in the negative gives an unnatural blackness to the sky that should be avoided as far as possible.

*Exposure time.*—As in all photographic work the exposure time varies according to the season, the time of day, illumination of the object, the density of the screen used, and other circumstances. With a Carbutt screen, or one of equal density, and a plate of sensitometer No. 20, an exposure of  $1\frac{1}{2}$  seconds stop f. 16 will suffice for a well-lighted sky at noon. It has been my experience, however, that it is best to err on the side of over exposure, and trust to the development to correct the result.

A short exposure, while giving the necessary detail, does not give sufficient contrast between cloud and sky, and it is quite difficult to bring out the clouds in bold relief in the subsequent process of printing. Some workers advocate short exposure and subsequent intensification, but the latter process is liable to permanently injure the plate and it is better to avoid it.

*Development.*—The development of the plate is one of the most important steps in the work.

There does not appear to be a decided advantage in using any one developer in preference to another. Pyro, hydrochinon, and metol may be used indiscriminately, but it is essential that the developer be strong in the reducing agent and highly restrained. The following formula, recommended by Mr. L. E. Jewell of Johns Hopkins University, has been used for several years and gives excellent results:

H	Hydrochinon	1 oz.
	Sulphite soda	5 oz.
	Water	25 oz.
C	Alcohol	3 drams.
	Carbonate of potassium	1 oz.
P	Water	100 oz.
	Yellow prussiate of potash	1 oz.
B	Water	100 oz.
	Bromide of potassium	1 oz.
	Water	10 oz.

For normal developer take—

75 CCH.  
12½ CCC.  
12½ CCP.  
11 drops B.

In general, the development of a cloud negative may be carried further than a simple landscape negative, and it is often necessary, especially in the case of the lighter clouds, to continue the development for some time after the image has apparently vanished from the plate.

It is important, in order to fix the position or the appar-

ent altitude and azimuth of the clouds in the sky, that a small stretch of the horizon be included in the view, and that the direction in which the view is taken, and the direction from which the clouds are moving, as NE., SW., etc., be noted on the photographic plate before development; note also whether the view is from before or behind, from the right or the left of the direction from which the cloud is coming. The entry can be made with an ordinary lead pencil in the corner of the plate. In fact, the date, stop used, and exposure time should all be noted on the plate for future reference.

The foregoing has reference solely to the production of single cloud negatives, and may be considered as the first step in the method of ascertaining the height, direction and rate of motion, and internal changes of clouds by the photographic process. The full method, however, demands the use of two cameras at either end of a measured base, and other apparatus for reducing the observations.

#### METEOROLOGY AND PUBLIC HEALTH.

By W. F. R. PHILLIPS, M. D., Editor of CLIMATE AND HEALTH.

The aim of this article will be to show briefly the connections between some of the meteorologic elements and public health, and to suggest some uses to which this knowledge may be put.

Although from time immemorial a belief in atmospheric influence upon health appears to have been held, yet real contributions to the knowledge of medical climatology date from a communication made to the Royal Society of London in 1797 by Dr. William Heberden, Jr., F. R. S., on the "Influence of Cold on the Health of the Inhabitants of London," wherein the author showed that a difference of 20° between the mean temperature in London in January, 1795, an excessively cold month, and January, 1796, an equally mild month, caused the deaths in the former to exceed those in the latter by 1,352.

In 1863 Dr. Scoresby-Jackson reported to the Royal Society of Edinburgh the results of a statistical investigation into the influence of weather upon the mortality of eight large cities of Scotland for the six years from 1857 to 1862. The most important result of this investigation was to show, for Scotland at least, that for every diminution of mean temperature below 50° F. there was a corresponding increase of mortality; but that for mean temperatures above 50° F. a diminution was favorable for vitality, at least if the temperature had been for any length of time above 50°. In other words, mean temperature and mortality from all causes had an inverse relationship below 50° F. and a direct relationship above 50° F.

One of the most important contributions to medical climatology was made to the Scottish Meteorological Society by Mr. Buchan and Dr. Mitchell in the communication of their researches into "The Influence of Weather on Mortality from Different Diseases and at Different Ages in London." The results of their labors are too extensive to be epitomized here, but their value may be estimated from the opinion of Dr. B. W. Richardson, that "from the researches of these distinguished men we can indeed forecast in this island [Great Britain] the course of many diseases with a precision that may, to a large degree, be called exact."

The researches of von Pettenkofer in Munich, and of Dr. Baker in Michigan, corroborated by those of other investigators, have established a connection between the depth of the water below the soil and the prevalence of typhoid fever. It appears that a fall of the subsoil water below its average seasonal level is very favorable for the appearance of typhoid fever. It is not to be supposed that the simple fluctuation of the water is a causative agency, but is suggestive of the conditions favoring the development of the typhoid germs.

The effects of high atmospheric temperature in causing an increased mortality from diarrheal diseases, and of a low

atmospheric temperature in causing a low mortality from these diseases, is an established fact that no one can dispute, but all attempts to express the diarrheal mortality in a given place as a function of the temperature only have failed. "The reason," says Dr. Longstaff, in his *Studies in Statistics*, "is probably a simple one, viz: That summer diarrhea is a disease very greatly influenced by temperature, but not caused by it alone; it is rather a communicable zymotic disease that thrives best during hot weather," bearing a direct relation to temperature and an inverse one to rainfall. Longstaff found that, for London, diarrheal diseases became epidemic when the temperature of the water of the Thames reached 62° F.

More than thirty years ago Dr. Henry Bowditch, of Boston, from an exhaustive study of the distribution of consumption in Massachusetts and elsewhere, showed that a residence upon damp soil, whether naturally so, or caused by percolation or defective drainage, was most favorable for the development of phthisis.

The statistical work of Dr. Baker of the Michigan State Board of Health, has added valuable information to our knowledge of some of the conditions under which bronchitis and pneumonia become prevalent. Dr. Baker has suggested as a probable explanation of the greater tendency to these diseases in cold weather, the fact that cold air is necessarily dry air, considered with reference to the weight of aqueous vapor contained, which when respired is exhaled at a much higher temperature, and contains a much greater amount of aqueous vapor than when inhaled. This increase in amount of vapor in the expired air has been acquired by evaporation from the respiratory passages, and is, according to Dr. Baker, a chief factor in the causation of inflammatory affections of these passages so greatly prevalent during the winter months.

An example will illustrate Dr. Baker's argument. At 32° F. a cubic foot of air can hold only 2.1 grains of water in the form of vapor, while at 98° F. (the temperature of the expired air) it can hold 18.7 grains, or 16.6 grains more than at freezing temperature. This illustration shows exactly what takes place whenever we breathe air at 32° F.

The following general propositions have been deduced from statistical considerations, and have been advanced with more or less authoritativeness by many writers on medical climatology:

1. A preternaturally dry air, with a high temperature, pre-disposes to the development of fevers and intestinal disorders.
2. A very moist atmosphere, accompanied by a low temperature, is likely to induce bronchial and rheumatic affections.
3. In summer and autumn the tendency to sickness and death is chiefly connected with the digestive organs.
4. In summer and autumn a rise of mean temperature above the average increases the number of cases of, and the mortality from, diseases of the digestive organs.
5. A cool and rainy summer controls the prevalence and fatality of diarrheal diseases.
6. Diarrheal diseases become epidemic when the subsoil temperature at a depth of 4 feet below the surface reaches 56° F. for the season.

Within recent years our knowledge of the causation of disease has undergone a very profound change, and many of the theories of atmospheric origin and effect have been shown to be untenable as originally propounded. But the change has been rather in the direction of transferring the effects of atmospheric agencies from man himself to the bacteria that are now universally recognized as the causes of infectious diseases.

In the future we must study the effects of the different meteorologic elements upon these lowly organisms, as well as on man himself.